

### Definition

A *cough* is a sudden, usually involuntary, expulsion of air from the lungs with a characteristic and easily recognizable sound. Although it is known as the most common symptom of respiratory disorders, it serves the functions of defending the respiratory tract against noxious substances and maintaining airway patency by removing excessive secretions from the air passages. *Expectoration* or *sputum production* is the act of coughing up and spitting out the material produced in the respiratory tract.

### Technique

A careful history, the most helpful task in the evaluation of patients with cough, will suggest the diagnosis of its cause in most instances. If the cough is not a part of the patient's presenting symptoms, its presence or absence should be determined by pointed questions not only directed to the patient but also to the spouse or other family members, as the patient may be unaware of a cough or may underestimate its frequency and duration. For example, it is not uncommon for patients with chronic bronchitis to be oblivious to their frequent coughing, while people around them are quite annoyed by it. Some patients may perceive their cough as "throat clearing." Many times, the truth about the patient's cough reveals itself to the observer during the interview and physical examination.

Once it is acknowledged that the patient has a cough, adequate information about its characteristics and circumstances should be obtained by appropriate questioning:

1. Was the onset of the cough sudden or insidious? What was its initiating event? Did it start as an isolated symptom or occur with or follow other symptoms?
2. How long has the cough been present? Is it persistent or episodic? Seasonal or perennial?
3. To determine the severity of the cough, ask: How frequent is a coughing spell? How long does each coughing spell last? What is its effect on daily activity or rest?
4. Is the cough productive or dry? Lack of expectoration does not necessarily indicate that the cough is dry, as many patients, particularly children and women, tend to swallow their sputum raised to the level of the pharynx. The sound of the cough would help in determining its productive or dry nature. Patients with sputum production should be asked about its frequency and description of the physical characteristics of the sputum including the amount (with each coughing spell and daily total), color, consistency, ease of its expectoration, taste, and smell.
5. Is the cough the only symptom, or is it associated with other respiratory or nonrespiratory symptoms? Inquiry should be specifically made about conditions known to cause the cough, particularly when it is chronic and persistent.
6. In addition to an accurate smoking history (see Chapter 40), ask: To what respiratory irritants is the patient exposed at home or at work? Is exposure accidental or intentional?
7. What are the precipitating or aggravating factors? What time of the day or night is the cough or sputum production worse? Does it happen in supine position, upon arising in the morning, with drinking or eating, with exercise, or with breathing cold or dry air? Does the cough awaken the patient from sleep?
8. Is there a past history (recent or old) of foreign body aspiration?
9. Has the pattern of the cough and the amount or other characteristics of the sputum changed recently?
10. Can the patient locate the site of origin of the cough or the sputum, such as from the throat or deeper in the chest?
11. Has the patient had a similar problem with coughing in the past?
12. Does the cough have easily recognizable characteristics, as in croup or whooping cough?

### Basic Science

The dynamic effect of a cough is the creation of an airflow velocity, within a certain portion of the airway, intense enough to shear and dislodge the secretions accumulated on the mucosal surface. Although coughing may be entirely voluntary, it is usually a physiologic reflex. As such, it is mediated through a reflex arc made of sensory receptors, afferent nerve fibers, a center, efferent nerve fibers, and effector muscles.

Cough receptors are considered to be the rapidly adapting nerve endings, which are also known as irritant receptors. These nerve endings are more plentiful in the mucosa of the larynx, carina, trachea, and large bronchi, which are readily stimulated by mechanical or chemical irritants. These are the portions of the airways in which the cough is most effective in clearing the secretions. The cough receptors have also been demonstrated or suspected in other sites, including the pharynx, peripheral airways, and other intra- or extrathoracic sites such as pleura, ear canals, tympanic membrane, and even the stomach. The vagus is the most important afferent nerve, although the glossopharyngeal and trigeminal nerves may operate, depending on the receptors involved. A medullary cough center has been postulated with no proof of its precise anatomic location. This "center" is under the influence of the higher voluntary nerve

centers, which may initiate or modify the cough. The efferent nerves are the vagi (recurrent laryngeals), the phrenic nerves, and the spinal motor nerves of the expiratory muscles.

The mechanical events involved in a typical cough are rapid successions of: (1) a fairly deep initial inspiration; (2) the tight closure of the glottis, reinforced by the supraglottic structures; (3) the quick and forceful contraction of the expiratory muscles; and (4) the sudden opening of the glottis while the contraction of the expiratory muscles continues. The very high intrapulmonary pressure generated during the last two phases results in a very rapid airflow from the lungs once the glottis is open. In addition, the pressure difference between the outside and the inside of the intrathoracic airways during phase 4 causes their dynamic compression and narrowing. The combination of a high airflow and airway narrowing results in the expulsion of an airstream with a linear velocity sometimes nearing the speed of sound. The blast of air thus produced is capable of expelling the secretions with a great force. The site and the extent of the dynamic compression are determined by the lung volumes. With large lung volumes, only the trachea and large bronchi are compressed; with smaller lung volumes, more distal airways are also narrowed. With each successive cough without an intervening inspiration, as seen in patients with chronic bronchitis, lung volumes become smaller, and the cough becomes effective also in removing secretions from more distal airways. With the ensuing deep inspiration, the cough restarts with larger lung volumes, and the cycle repeats itself.

The characteristic explosive sound of coughing results from the vibrations of the vocal cords, mucosal folds above and below the glottis, and the accumulated secretions. Variation in sounds of coughing is due to several factors, including the nature and quantity of secretions, anatomic differences and pathologic change of the larynx and other air passages, and the force of the cough. Vibrations of coughing also help in dislodging secretions from the airway walls.

The small amounts of tracheobronchial secretions normally produced are very effectively handled by the mucociliary clearance mechanism. These secretions are made up of water, dialyzable substances such as electrolytes and glucose, mucus glycoprotein, indigenous and transudated proteins, and lipids (surfactant). The mucous glands and goblet cells are the primary sources of the tracheobronchial mucus. By forming a thin blanket, the airway mucus covers the ciliated epithelium. Rhythmic vibrations of cilia propel it toward the pharynx from where it is swallowed, usually unnoticed. A proper balance between its formation and its clearance maintains a thin protective layer of mucus for trapping and removing the impurities of the inspired air while preventing the excessive accumulation of secretions. With an adequate function of the mucociliary escalator, the cough has no additional benefit in removing the amount of secretions formed under normal conditions. In pathologic states, however, when the mucociliary function is ineffective or insufficient because of the quantity or alteration of the physical properties of secretions, the cough becomes essential for airway clearance.

Although coughing is most effective when the excessive secretions are accumulated in the large, centrally located airways, it also plays an important role in clearing the peripheral airways in situations in which there is impaired mucociliary clearance, as in chronic bronchitis, cystic fibrosis, or primary ciliary dyskinesia (immotile cilia syndrome).

A "milking" effect of coughing on peripheral airways has been suggested as a mechanism of its action in removing secretions from these sites. This requires coughing at low lung volumes when the secretions are squeezed out of the small airways toward more centrally located bronchi.

In addition to the mucus, the expectorated sputum may contain other endogenous or exogenous materials, including transudated or exudated fluids, various local or migrated cells, microorganisms, necrotic tissues or cells, aspirated vomitus, or other foreign particles. Gross appearance and other physical characteristics of the sputum are the result of its content of these and other materials. Mucous sputum is clear or translucent and viscous, containing only small numbers of microscopic elements. Purulent sputum is off-white, yellow or green, and opaque. It indicates the presence of large numbers of white blood cells, especially neutrophilic granulocytes. In asthmatics, the sputum may look purulent from the eosinophilic cells. Red coloration, uniform or streaky, is usually due to its mixture with blood. Carbon particles discolor the sputum gray (as in cigarette smokers) or black (as in coal miners or with smoke inhalation).

### Clinical Significance

As a cardinal manifestation of respiratory diseases, coughing is one of the most common symptoms encountered in clinical medicine. Being a physiologic reflex, the cough also occurs without any demonstrable evidence of disease when triggered by the stimulation of the irritant receptors. Moreover, it may be a voluntary act or may result from nervous habit. Although the clinical significance of coughing in many instances is trivial, it may be an indication of a serious intrathoracic disease. Pathologic conditions causing the cough are usually the ones that irritate the airways, increase their irritability, result in their deformation, or increase the tracheobronchial secretions. These factors may operate singly or in various combinations. Sputum production with coughing occurs when the respiratory tract secretions are beyond the ability of the mucociliary mechanism to deal with them.

The most common cause of the *acute cough* of clinical significance is viral tracheobronchitis. The cough in this transient and self-limited condition is, at the beginning, nonproductive and quite annoying; later it becomes productive of mucous or mucopurulent sputum before it begins to subside. Inflammation of the respiratory tract mucosa, from infectious or noninfectious causes, results in hyperactivity of the cough receptors. This results from the alteration of the surface epithelium, making them more sensitive to the cough-producing effect of commonly occurring mild irritants such as cold air, respiratory pollutants, deep or fast respiration, and excessive use of the larynx. At times, the mechanical irritation of coughing itself brings about more coughing. Inflammation, in addition, increases the secretions. In acute viral respiratory tract infection, postnasal drip may be another cause for triggering the cough. Other infectious, as well as noninfectious, diseases of upper or lower respiratory tract are known for their propensity in causing the cough as a part of their clinical manifestations (Table 38.1).

A *chronic cough*, defined as a cough lasting for a minimum duration of 3 weeks, is usually indicative of structural changes in the respiratory tract or the persistence of other cough-stimulating factors. By far the most common cause of a chronic cough in developed nations is tobacco smoking,

**Table 38.1**  
Anatomic Classification of Causes of Cough

Causes with their anatomic locations	Mechanism	Characteristic features and major associated symptoms
<i>Nose and its sinuses</i> Rhinitis, sinusitis	Postnasal drip irritating upper airway cough receptor	Acute or chronic cough with sensation of postnasal drip, frequent hawking (throat clearing), nasal stuffiness
<i>Pharynx</i> Infection, neoplasm	Irritation of pharyngeal cough receptors	Hacking cough with sore throat, frequent hawking
Zenker's diverticulum	Irritation of airways by compression or by aspirated diverticular content	Regurgitation of undigested food, halitosis, dysphagia
<i>Larynx</i> Infection, allergy, neoplasm, foreign body	Hyperreactivity of laryngeal cough receptors, mechanical irritation	Croupy or barking cough, change in voice, inspiratory stridor
Improper use of voice	Vocal cord irritation	Coughing with talking or singing
<i>Trachea and bronchi</i> Acute tracheobronchitis	Hyperreactivity of cough receptors, increased secretions	The most common cause of acute self-limited cough
Pertussis	Hyperirritability of cough receptors from necrotizing inflammation of respiratory tract mucosa	Paroxysms of coughing ending in a loud, crowing, inspiratory sound (whoop); expectoration of mucus plug
Chronic bronchitis	Hypersecretion, ciliary dysfunction	Chronic productive cough of smokers, worse upon arising in the morning
Bronchiectasis	Hypersecretion, retained secretions	Expectoration of large amounts of foul-smelling sputum, hemoptysis
Cystic fibrosis	As in bronchiectasis, secretions more viscid	Chronic cough since early childhood, progressive dyspnea, hemoptysis
Neoplasm	Mechanical irritation of cough receptors by tumor, secretions, or secondary infection	Change of pattern of cough in a long-time smoker, hemoptysis
Bronchial asthma	Airway hyperreactivity, bronchospasm, increased secretions	Recurrent or chronic cough with or without wheezing or dyspnea
Aspiration	Irritation of cough receptors by aspirated material, secondary infection	Nocturnal cough, frequent heartburn, swallowing disorder
Foreign body	Mechanical stimulation of cough receptors, infectious complication	History of foreign body aspiration (may be forgotten)
Inhalation of irritating gases or aerosols	Chemical irritation of cough receptors	Onset of cough immediately after exposure
<i>Pulmonary parenchyma</i> Pneumonia	Stimulation of peripheral cough receptors, increased secretions	Initial dry cough usually followed by varying sputum production dependent on the cause; systemic symptoms of infection
Lung abscess	As in pneumonia	Sudden onset or increase in amount of purulent, often foul-smelling sputum
Tuberculosis and other chronic infections	As in pneumonia	Chronic, usually productive, cough; hemoptysis
Chronic infiltrative or fibrosing lung disease	Irritation of peripheral receptors, distortion of airways	Chronic dry cough, progressive dyspnea
Pulmonary edema (cardiac or noncardiac)	Hypersecretion, airway hyperreactivity from congestion	Acute cough with severe dyspnea, frothy and blood-tinged sputum
<i>Esophagus</i> Swallowing disorders	As in aspiration	Frequent choking on food or drink
Esophageotracheal and esophageobronchial fistula	Stimulation of cough by passage of swallowed liquid to airways	Coughing upon swallowing liquids
<i>Heart and blood vessels</i> Left-side heart failure	As in pulmonary edema	As in pulmonary edema, nocturnal cough
Aortic aneurysm, left atrial enlargement	Compression of large airways	Nonproductive cough
Pulmonary thromboembolism	Largely unknown; irritation of peripheral or pleural cough receptors with infarct	Acute cough, dyspnea, hemoptysis
<i>Mediastinum</i> Mediastinal tumors	Airway compression and deformation	Nonproductive, "brassy" cough, sometimes related to body position

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Table 38.1 (continued)

Causes with their anatomic locations	Mechanism	Characteristic features and major associated symptoms
<i>Pleura</i> Pleural effusion	Irritation of pleural cough receptors, airway deformation with large effusion	Dry cough, chest pain, dyspnea
<i>External ear canal and tympanic membrane</i>	Stimulation of cough receptors by hair, cerumen, or foreign body	Occasional cause of dry cough eliminated by removing the cause
<i>No organic causes</i> Psychogenic cough Intentional cough	Habit cough (respiratory tic) Deliberate cough for attention seeking or other personal gain	Dry cough, absent during sleep Dry and noisy cough occurring only in presence of people
Drug-induced cough (angiotensin-converting enzyme inhibitors)	Not known	Dry, annoying, and often incessant cough, disappearing after stopping the drug.

which is the most important factor in the etiology of chronic bronchitis. In this disease, the cough is productive of a fairly large amount of sputum that varies from mucous to mucopurulent. Patients with chronic bronchitis, well accustomed and often oblivious to their symptoms, become concerned when the characteristics of their cough and sputum production change. The most frequent cause for the change is the intercurrent of an infection; however, it may indicate the occurrence of a neoplasm.

Since the decline of tuberculosis in developed nations, lung cancer has become most feared among the people with a chronic cough. The cough in lung cancer may develop *de novo* when there is no underlying chronic bronchitis and may be its only manifestation. As chronic bronchitis and lung cancer are very uncommon among nonsmokers, a chronic persistent cough has a different significance in this population. Airway hyperreactivity, the hallmark of bronchial asthma, is a rather common condition in which the cough may be the predominant or even the sole manifestation. Patients with hyperreactive airways, without other manifestations of asthma, may have a chronic cough for as long as several years until the condition is suspected, accurately diagnosed, and properly treated. Chronic postnasal drip, a frequent symptom of allergic or nonallergic rhinitis and/or sinusitis, is implicated in many instances of a chronic cough. A sensation of secretions dripping down into the throat and the feeling of a need to clear the throat are very suggestive of this disorder.

The chronic cough may be a manifestation of many other pathologic conditions involving the intra- and extrathoracic organs (Table 38.1). Left-sided heart failure not only results in a cough with acute pulmonary edema but also may be a cause of a chronic nocturnal cough. Recurrent aspiration is another condition in which the cough characteristically occurs in a supine position. Foreign-body aspiration should always be considered in the differential diagnosis of the chronic cough. After the initial coughing or choking episode at the time of its aspiration, the cough may restart and continue long after the incident. Other, less common intraluminal or compressing lesions of the tracheobronchial tree, chronic inflammatory or fibrosing lung diseases, and extrapulmonary lesions may have cough as their predominant symptom. Tumors of the mediastinum, enlarged heart chambers, and pleural disease may manifest with cough. A psychogenic or intentional cough for personal gain should

be seriously considered only when other causes are properly excluded. The angiotensin-converting enzyme inhibitors such as captopril and enalapril, used for the treatment of hypertension and congestive heart failure, are being increasingly recognized as a cause of a dry, annoying, and often incessant cough, which disappears only after the discontinuation of these agents.

Characteristics of expectorated sputum often suggest the diagnosis of its cause. Chronic expectoration of large amounts of purulent and foul-smelling sputum is strongly suggestive of bronchiectasis. Sudden production of such a sputum in a febrile patient indicates a lung abscess. Rust-colored purulent sputum in pneumococcal pneumonia, currant jelly and sticky sputum in klebsiella pneumonia, and blood-tinged foamy sputum in pulmonary edema are other examples in which the diagnosis of the underlying disease is strongly suggested. A cough with the expectoration of blood (hemoptysis) is discussed in Chapter 39.

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